Science advantages of an oversnow traverse to resupply S. Pole

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1.1 Executive Summary

An oversnow traverse and resupply of S. Pole Station, using the safest and easiest route through West Antarctica, would expand the scope and impact of Antarctic science. In the short term we envision a significant increase in the amount of science that can be supported. This short-term gain is realized directly in increased science tasking for LC-130s as the Pole resupply missions are freed up by oversnow traverses. We estimate that one-third to one-half of the current Pole resupply flights could be made available for science. Broader science impacts will come about because of the extended season in West Antarctica and the opportunity to support new types of science investigations. We estimate that the West Antarctic science season would be extended by three to four weeks. In the long term, we see this capability contributing to fundamentally different styles of science than are currently supported. With a robust traverse capability, science investigations may be conducted along geographical corridors, rather than from fixed sites as is currently done. These high-resolution, regionally extensive surveys are needed to address emerging scientific questions that cannot be solved solely by the camp-based datasets heretofore collected.

An oversnow traverse to S. Pole could service and support both Pole as well as “midway” camps in central West Antarctica and in the Transantarctic Mountains. These midway camps would be hubs for supporting science in their surroundings in an efficient manner. They could be visited earlier in the spring and kept open longer in the autumn than is currently possible with LC-130 transport. Structures in these camps (and other traverse-deployed camps) could employ modular, super-insulating designs to reduce fuel consumption and environmental impact as well as improve camp operations, maintenance and upkeep.

Finally, we believe that the traverse capability will result in a “paradigm shift” in the Antarctic research community, and that scientists will propose innovative investigations that we cannot as yet predict. Among the ideas already discussed in conjunction with this idea are larger telescopes for South Pole (transported by the traverse vehicle), glaciological and geophysical investigations of the East Antarctic, and support for the Inland WAIS deep ice core site.

1.2 Introduction

The US Antarctic program has always been a pioneer in flight operations in the Antarctic. This has allowed the US to continuously maintain well-supported science programs in the interior of the continent, far from the ship- and wheeled-aircraft-based coastal stations. The crown jewels of this capability are the ski-equipped LC-130 fleet, which are unique to the US Antarctic Program. These heavy-lift, long-range aircraft, with their deep-field landing capability (i.e., landing in areas without prepared skiways) have been instrumental in allowing research to be carried out virtually anywhere on the continent.

The LC-130 fleet is tasked with approximately 450 flights per year to carry out the science support, station support, Antarctic Treaty commitment support, and other commitments (mainly flight training and aircraft certification). The majority of the flights are in two categories: (a) support of science directly (i.e. transportation of scientists, scientific equipment, and science-support equipment to field research sites) and (b) fuel and materials re-supply of S. Pole station. Table 1 summarizes the annual tasking for the LC-130s for the coming 5 years, where we have highlighted the significant size of the Pole resupply effort.

The US was also a leader in mechanized oversnow traverses for scientific research and exploration. These traverses from the late 1950's continuing on into the 1970's were fundamental in advancing our understanding of the Antarctic. This oversnow traverse mode of operation has largely ceased in the last two decades, with the significant exception of ITASE (International Trans Antarctic Scientific Expedition). There were many reasons for the shift of emphasis to the air-supplied field camps from the traverse mode of operation, including a desire to do targeted research rather than broad-brush exploratory research.

We suggest that it is time to allow the pendulum to swing back from the extreme of all-air-supported work to include more traverse-based research. The Antarctic is increasingly recognized as extremely heterogeneous, and results obtained in one location are difficult to extrapolate beyond relatively short distances (perhaps 10's to 100's of km). The extraordinary results of recent satellite-based work (Radarsat, Landsat, declassified DoD imagery) and airborne geophysics all point to the variability of glaciological, geological, climatological, atmospheric, and other parameters on strikingly short distance scales. There is an increasing need for corridors of research and data that can allow the interpretation of these remotely collected data on a large scale. There have been numerous targeted research projects (e.g., RISP, RIGGS, the Siple Coast Project, the various ice cores, work by the different national programs at Dome C and F, etc.) that need to be linked together in the context of the satellite work.

An oversnow traverse to S. Pole would accomplish three things: (a) increase the number of LC-130 flights for deep field research, (b) reinvigorate the US capability for oversnow travel and research, and (c) provide an operational base camp in West Antarctica for aircraft-supported science programs.

	FY02	FY03	FY04	FY05	FY06
Deep Field Science	61	140	137	157	159
South Pole Science	12	47	64	66	76
South Pole Operations	182	182	182	182	182
South Pole Construction	183	123	57	71	
Other	7	7	7	7	7
Total	445	499	447	483	424
LC-130 Capability	355	355	355	355	355
Shortfall	-90	-144	-92	-128	-69

Table 1 Estimate of LC-130 demand and supply (as of 4/1/01).

1.3 Science Benefits

1.3.1 West Antarctic Midway camp science benefits

We suggest that the feasibility of developing two different oversnow traverse routes to Pole be considered. The work of G. Blaisdell (CRREL), presented at the Pole-resupply workshop, suggested that two realistic possibilities are the low-gradient West Antarctic route ("ice stream C route") or a more technically challenging Transantarctic Mountain route ("Leverett Glacier route") (Fig. 1). The ice stream C route is considerably longer, but the relative simplicity of the route and the low gradient could compensate for the extra travel distance. A third possibility is a circular route that combines both routes: from McMurdo up ice stream C to Pole, and then back via Leverett Gl.

A traverse route through the West Antarctic would allow the US to establish a couple of permanent summer settlements in areas of historically high science interest and activity. A small midway camp in a location such as the head of ice stream C could serve as a hub for logistics throughout the West Antarctic. Such a camp could be opened up early in the year by an oversnow traverse with less regard to the weather in McMurdo. Because of our dependence on LC-130s for all operations, the weather in Oct/Nov tends to delay the start of science in the West Antarctic. West Antarctic camps tend to have problematic put-ins (put-in=first landings at the camps), low ACLs until the skiways are prepared (ACL=allowable cargo loads on the LC-130s), and relatively late science operations start up (approximately 15 Nov).

With a flagged traverse route to the West Antarctic, oversnow traverses in mid/late Oct could occupy this camp and call weather for the LC-130 science put-ins. We envision an expansion of the science season by as much as three weeks, a significant improvement in a season that averages 8 weeks (mid/late Nov to mid Jan). A further benefit of establishing a camp with a prepared landing strip in West Antarctica is that it would provide more support options for small deep-field parties (4-6 people). In the past few years, deep-field put-ins by LC-130 to areas without prepared landing strips have been problematic. A field group could be transported to the midway camp by LC-130, and then moved from there to their final destination by Twin Otter aircraft, which are very well-suited to deep field landings at unprepared sites. The Twin Otter aircraft, using the midway camp for support, could then also be used for camp moves during the field season. The option of this type of put-in and camp move capability will allow small deep field parties to spend longer in the field, work more efficiently, and will provide an added degree of flexibility in air support. A camp at the head of Leverett Glacier would have some of the same benefits as the W. Antarctic traverse camp. Traditionally, significant geologic research in the Transantarctic Mountains is done from occasional large hub camps (e.g., Shackleton Gl. camp in 1997, Darwin Gl. camp in 2000). The Leverett camp would be a hub for helicopter and fixed-wing ops in a reach of mountains that are not easily accessible from McMurdo.

1.3.2 Traverse capability

Developing a traverse capability could have significant direct science impacts, aside from the ancillary benefits of shifting flights from logistics to science. A paradigm shift in operations, from the current central camp based science ("learn lots about a small area") to a combination of central-camp-based science and traverse-based science ("link together those places you learnt a lot about...") would yield benefits in novel ways.

Assessing spatial and temporal variability on short distance- and time-scales, respectively, will be the challenge of the Antarctic sciences in the coming decade. Conducting traverse-based research on a routine basis will allow the high-resolution sampling of glaciological parameters (in particular accurate accumulation and temperature measurements) subglacial geology (through high resolution seismics), meteorology, climate sciences, and aeronomy. Understanding the detailed response of the ice sheet to climate change and resolving the question of anthropogenic forcing will require this high-resolution dataset to feed the models.

Two technical developments of the last decade have made this mode of operation safe and practical: GPS navigation and crevasse detection through a combination of satellite imagery and ice-penetrating radar. Combined with better communications (via Iridium currently, or some alternative if Iridium fails), traverses can be conducted over a significant percentage of the continent with safety and reliability. There will always be a need for LC-130 based camp deployments in highly crevassed areas like the ice streams. The traverse capability will be able to improve the efficiency of those camps by pre-staging materiel close to the final target.

1.3.3 Direct Science Benefits for Pole

Carrying fuel and cargo oversnow to Pole would remove some of the limitations of the current method. Larger individual items could be carried South, resulting in cost-savings from economies of scale. More importantly, removing the critical size limitation of the LC-130 cargo bay would allow scientist to (literally!) think outside the box and envision new types and modes of science such as using large telescopes.

1.4 Logistics Benefits: Pole resupply and W. Antarctic Logistics

The LC-130s have the ability to deliver 10,000-30,000 lbs of fuel and equipment to almost anywhere on the continent. We suggest that devoting a significant percentage of their effort on fuel flights for Pole is not the best use of their unique talents. There are other mechanisms for resupplying Pole, but the LC-130 aircraft provide the most efficient means for conducting small- to medium-scale science in the interior of the continent (i.e., 4 - to 20-person camps). Furthermore, the LC-130 fleet is arguably not the best platform for the role of Pole resupply. They consume 1 gallon of fuel for every delivered gallon; they have a cargo compartment that has strict size limitations; there are strict weight limitations; the aircraft schedule is at the mercy of weather.

Different methods for resupplying Pole were discussed in an NSF-OPP sponsored workshop (workshop report in preparation). These methods range from airdrops to orbiting tankers that service a fleet of mid-air-refueling LC-130s to blue-ice runways near Pole to oversnow traverses. All the alternatives have advantages and costs, but of them all, the oversnow traverse has the greatest potential to advance scientific research while at the same time efficiently resupplying Pole.

1.4.1 Flight Savings

A realistic assessment of the oversnow traverse suggests that approximately half of the 180 annually-needed Pole resupply flights would be freed up for other tasking, resulting in an increase by one-third in the deep-field science availability of LC-130 flights (from approx 250 to approx 340). An additional savings of a few flights will be realized by efficient operations (weather obs in W. Antarctica will result in fewer turnarounds on put-in) and higher ACLs from the start (the skiway can be prepared before the first flight).

Finally, the oversnow traverse is an extremely reliable, all-weather method ensuring that Pole will receive a steady flow of fuel all through the summer regardless of aircraft maintenance issues or McMurdo weather. For example, in the 2000-2001 season, Pole came within a few days of broaching their emergency fuel. The SPSM was delayed by a year because enough material could not be delivered to Pole. An oversnow traverse would remove these uncertainties.

1.4.2 Camp Architecture

A significant improvement in camp operations could result from the traverse capability. Today's camps are decades old in their design and architecture. Jamesways are heavy, poorly insulated, and inefficient in terms of usable space. They require specialized skills to raise and make habitable, as well as to tear down. The structures in the field camp of the future should be lightweight, modular, super-insulated, energy-efficient (and possibly energy self-sufficient) and easily transportable. A small number of standardized modules (Galley, Berthing, Science, Mechanical, etc) would be towed along the traverse route or towed to a new campsite for semi-permanent occupation. These modules would overwinter in the field and could be made ready for occupation quickly every year.

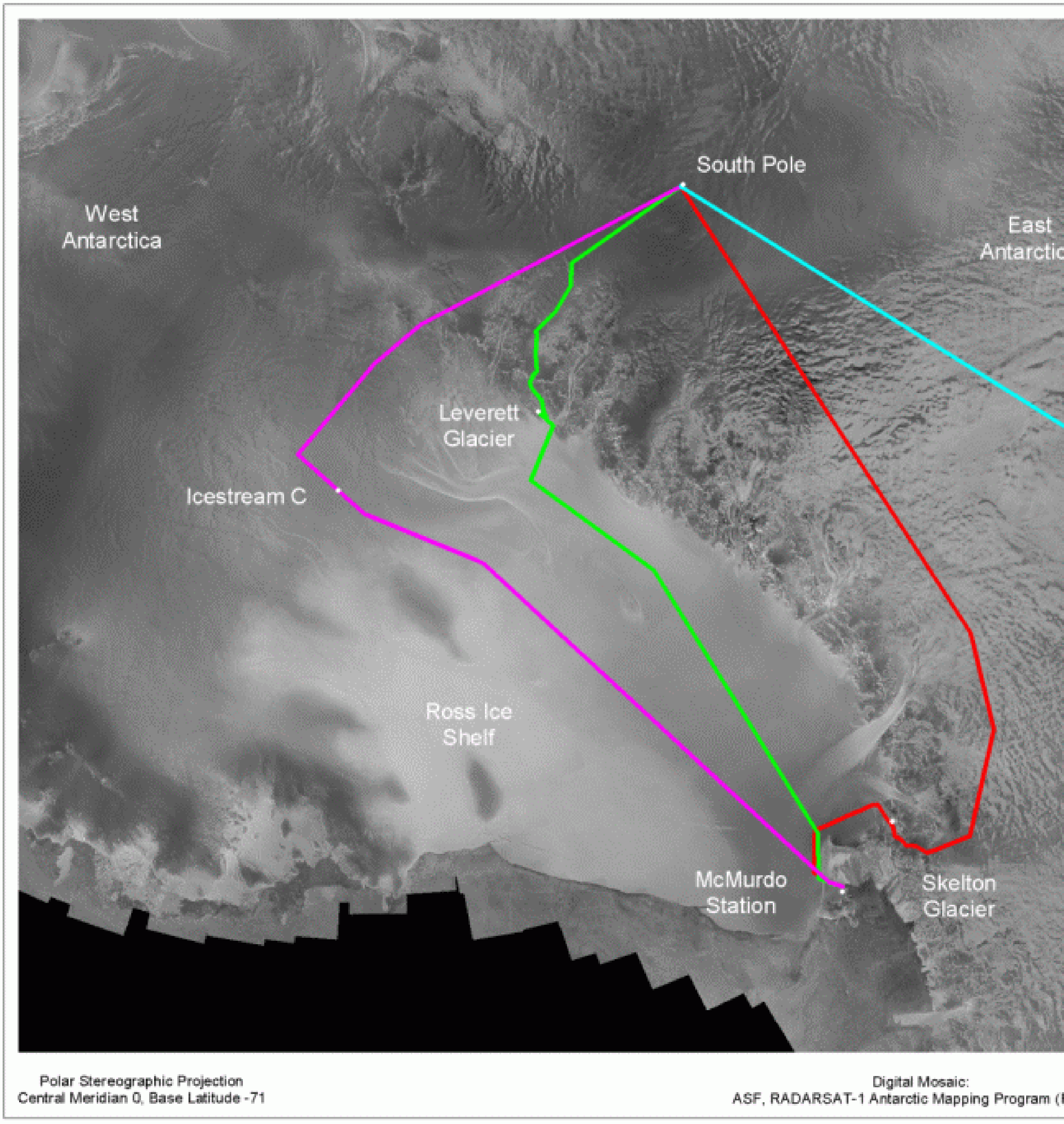

Figure 1 Possible routes to S. Pole Station. From East to West, they are the ice stream C route (in purple), the Leverett Gl. route (in green) and the route that Edmund Hillary took to Pole in 195x (red).